C R 115288

SPACE STATION BUILDUP SIMULATION

FINAL REPORT

1.0 Introduction

This report summarizes the work performed under Exhibit B of Contract No. NAS9-11948.

The major portion of this effort was a dynamic simulation of the visual scenes associated with the buildup of a Modular Space Station. It resulted in a color motion picture depicting the simulation of selected earth orbital operations. The remainder of the effort was devoted to a review of the Guidance and Control Division's Electronic Scene Generator equipment operational capability. The results of these tasks are described below.

2.0 Results

2.1 Space Station Simulation

The objective of this effort was to obtain simulations of selected earth orbital operations involving the Shuttle Orbiter and various modular space station components. Data on the physical characteristics of these items, such as size, shape, and configuration, as well as the current operational concepts were obtained from NASA, MSC and from drawings and sketches provided by North American Rockwell. These data reflected the concepts as of July 1971 and formed the basis for the numerical models and dynamics used in the simulations.

Numerical models were developed for the Space Shuttle Orbiter and components of a six-man initial station including a core module, power module with solar arrays, representative station modules, and various sensors and antenna. These models were used with the Computed Display Research Facility at General Electric's Electronics Laboratory, Syracuse, New York to conduct the simulations.

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The simulation dynamics were modeled to provide motion for each simulation part including Sortie mode operations and detailed sequences showing delivery, manipulation, and assembly of station components. The dynamics were designed to depict the functional sequence of a large number of events in compressed time.

The simulations were documented on 16mm color film. The film, containing approximately 17 minutes of simulations, and a descrption of its 39 scenes were delivered to NASA, MSC on October 19, 1971. A list of the numerical models and their complexity is given in Appendix A.

2.2 Electronic Scene Generator Review

The ESG system generates real-time scenes of the type used in the above simulations. A review of this system was conducted to evaluate its potential for future studies of this type. The ESG has two main subsystems; one for three-dimensional object generation and one for surfaces. Inasmuch as the object portion of the system is currently being expanded and improved, the review centered on the surface subsystem (SGS) which has been in operation in the system for approximately 7 years.

The review included an inspection of maintenance and failure reports, discussions with operating and service personnel and a detailed examination of the equipment. No incipient long-term reliability problems were found. Most of the current maintenance difficulties were isolated to a single area and it was recommended that a small section of the equipment be replaced with a more reliable semiconductor counterpart. Details of the SGS Review are given in Appendix B.

R. A. Schumacker
Visual Simulation
November 29, 1971

APPENDIX A

SIMULATION MODELS

Item	Number of Faces
1. Shuttle Orbiter	850
2. Manipulator (7 sections)	474
3. Earth Observation Payload	411
4. Core Module	284
5. Service Module (7 used)	258
6. Power Module with Arrays	692
7. Adapter	132
8. Airlock (solid)	60
9. Airlock (hollow)	140
10. Intermodule Tunnel (2 used)	50
11. Airlock Cameras	326
12. Radiometers (6 used)	20
13. Antenna (dish)	144
TOTAL	3 841

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APPENDIX B

SGS REVIEW

This report describes the SGS inspection conducted on Contract No. NAS9-11948. The purpose was to determine if the Surface Generation System portion of the Electronic Scene Generator could be operated reliably for the next five (5) years. Two recommendations are made.

1.0 Inspection Summary

The SGS inspection was conducted at NASA MSC during the period September 27, 1971 to September 30, 1971. During this period discussions were held with NASA and Lockheed personnel concerning the specific areas in which reliability problems had been experienced. The Lockheed maintenance log was reviewed. The SGS output video was scrutinized for noise and errors and several internal SGS signals were examined. Several minor problems were fixed mostly relating to the SKY video.

2.0 Conclusions

Nothing was observed during this investigation that would indicate that any part of the SGS was deteriorating. The picture quality was good and the system appeared to be operating properly. No long-term reliability problems were observed. There are, however, two major contributors to the short-term reliability problems. First, the SM-32 sonic delay lines in the LASU are major sources of picture noise because they require periodic maintenance and are difficult to adjust and repair. Second, numerous references were made both in the discussions and in the maintenance log to intermittent problems which disappeared before they could be fixed. The problem occurs during a study and the study is continued, if possible, in spite of the problem. In many cases the problem disappears before maintenance time is available.

3.0 Recommendations

The Short-term reliability of the SGS would improve significantly if the two problems mentioned above were solved. The solution to the SM-32 problem is relatively straightforward. When the SGS was designed in 1963-1964, the SM-32 was a relatively reliable form of small digital memory. Since that time the semiconductor technology has greatly advanced and much more reliable semiconductor replacements for the delay lines are available. The semiconductor replacements would require no periodic maintenance or adjustment and repairs could be made very easily.

The solution to the second problem is not that easy. Assuming that the present operating procedure is desirable (that of continuing the study in spite of the problems), the only solution to the problem of intermittent failures is to be more formal with regard to the maintenance procedures. When a failure occurs and the decision is made to continue the study in spite of the failure, detailed notes should be made as to the type of failure and the conditions under which the failure occurred (roll, pitch, heading, X, Y, and H, problem computer configuration, environment tape loaded, etc.). At regular intervals the ESG should be reserved for maintenance and every effort made to duplicate the conditions under which the failure occurred. A running total should be kept of the number of unsolved problems to determine if the maintenance schedule being observed is satisfactory or should be modified. The list should be reviewed periodically to remove failure entries which cannot be repeated and have not reappeared. A formalized maintenance schedule of this type should tend to decrease the number of intermittent failures.

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